NAI Focus Group

NASA ASTROBIOLOGY INSTITUTE

S. Blair Hedges, Co-Chair
Department of Biology
Pennsylvania State University, University Park, PA
sbh1@psu.edu

James A. Lake, Co-Chair
Molecular Biology Institute
University of California, Los Angeles, CA
lake@mbi.ucla.edu

The purpose of the Evolutionary Genomics (EvoGenomics) Focus Group is to coordinate, combine, and enhance research efforts involving evolutionary genomics across the multiple disciplines and institutions represented in the astrobiology community. Evolutionary analysis of the complete genomes of organisms has greatly advanced our understanding of how life originated, adapted to diverse environments, and increased in complexity on this planet. In turn, these studies will lead to a better understanding of life elsewhere in the Universe. The EvoGenomics Focus Group is a unique collaboration of astrobiologists combining expertise in molecular evolutionary analysis, organic chemistry and biochemistry, Earth history, and paleontology. Our unifying goal is to compare the early evolutionary history of life, as revealed through analyses of genomic sequence data, with changes in Earth's environment through time, providing the basis to identify biomarkers for habitable planets.

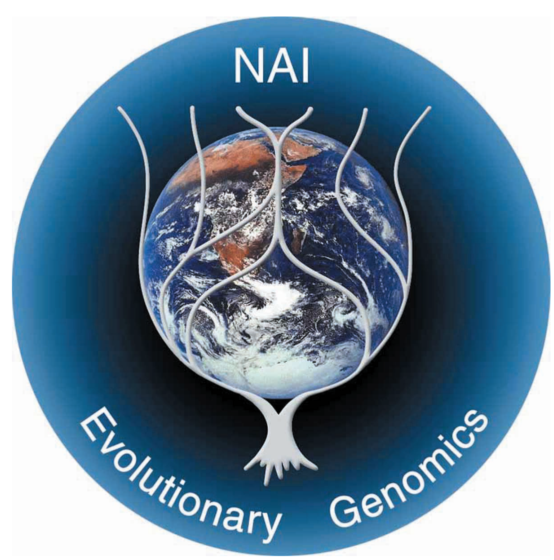
Background

Evolution of Gene Function

The biological function of a protein from a living system must be understood in its various contexts: the pathway, the cell, the organism, and, ultimately, the ecosystem and the biogeosphere. These contexts yield a Darwinian definition of "function", a statement of how the protein contributes to the survival and reproduction of its host organism. Assigning function to a protein sequence ("annotation") is now a prominent task, thanks to genome sequencing projects. In general, those charged with annotating genomic sequence databases understand that evolutionary models are central to this task. Knowledge of natural history, the fossil record, and geological record can improve our understanding of biomolecular function. Research here includes documentation of recruitment in prokaryotic and eukaryotic proteins and development of computational tools to extract signals of form and function. In turn, these data will help to reveal patterns in adaptation at the molecular level pertinent to astrobiology.

Neoproterozoic Evolution and Animal Origins

Knowing how life on Earth was affected by major environmental perturbations is helping us understand how life might have evolved and adapted elsewhere in the Solar System and beyond. This collaborative effort is using



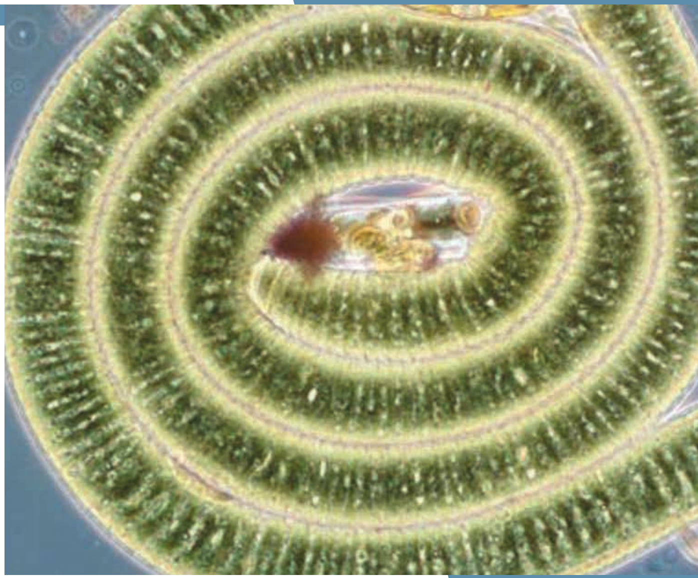
Evolutionary analysis of the genomes of organisms will help to build a clearer picture of how life originated, adapted to diverse environments, and increased in complexity on this planet.

genomic tools to study the influence of geologic and planetary-scale climatic events during the Neoproterozoic, 1000-545 million years (Ma) ago, on the early evolution of metazoans (animals).

Evolutionary Patterns of Horizontal Gene Transfer

Many genes were transferred following the symbiotic events leading to the origin of eukaryotes. Horizontal gene transfer also has occurred at other times during the evolution of prokaryotes and eukaryotes. Not all genes are equally likely to be horizontally transferred, and a major goal is to reveal the factors that control the relative horizontal transferability of genes. Discovering the rules for gene transfer is important if we are to understand gene flow between genomes, gene flow between and within habitats, and even gene flow between Earth and other habitable systems. The availability of genomes from diverse prokaryotes, and from model eukaryotes, provides a unique opportunity to examine the factors controlling horizontal transfer.

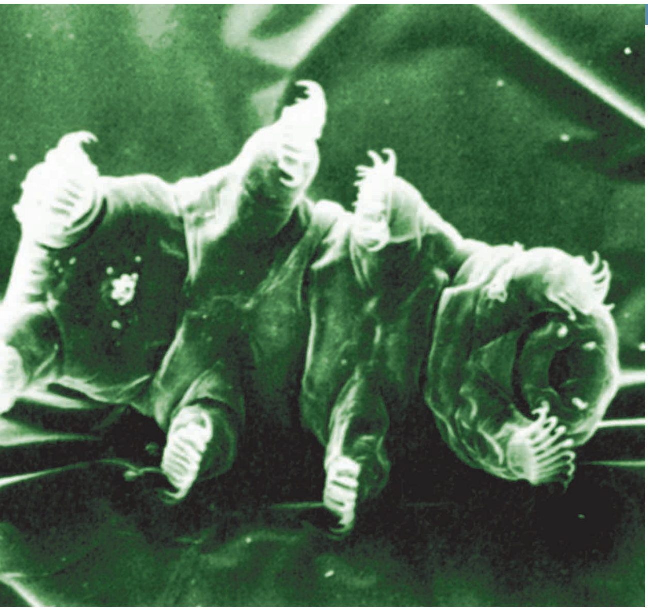
Additional background information highlighting the multidisciplinary and collaborative nature of the research can be found at www.evogenomics.org.



Lyngbya may be the oldest recognizable organisms on Earth, traceable back to the earliest fossils, over 3 billion years old. Photo Credit: David Patterson, Linda Amaral-Zettler and Virginia Edgcomb.

Recent Activities

During the past year the EvoGenomics Focus Group has engaged in a wide variety of activities including: collaborative research, an EvoGenomics Workshop held at UCLA (March 9-11, 2001), a breakout session at the Year 2001 NAI General Meeting, videoconferences, and the development of an EvoGenomics Focus Group website.



Tardigrades are well known for their ability to greatly reduce their metabolic activity during unfavorable conditions. Understanding how these organisms adapt to diverse environments will further our understanding of life elsewhere in the Universe. Image credit: Kristensen and Hallas 1980.